



Integrated Petroleum Technologies, Inc.

April 03, 2015

Ms. Susana Lara-Mesa  
Wattenberg Disposal, LLC  
1675 Broadway, Suite 2800  
Denver, Colorado 80202

CO 10938-02115

RE: EPA Falloff Test Analysis  
Suckla Farms Injection Well (EPA) #1  
API # 05-123-14291  
SHL: 2140' FNL, 2020' FEL  
Section 10 T1N R67W  
Lyons Sandstone  
Weld County, Colorado

Dear Ms. Lara-Mesa:

The EPA pressure falloff test analysis is attached for the Suckla Farms Injection Well (EPA) #1, Weld County, Colorado.

IPT appreciates the opportunity to work with you and Wattenberg Disposal on this analysis. Please do not hesitate to call if you have any questions or require additional assistance.

Sincerely,

Joel Mazza  
Production and Reservoir Advisor

Eric Marshall, P.E.  
Reservoir Engineering Manager



2 Entered  
Date 4/29/15  
Initial JB

	GREEN	BLUE	CR
TAB		2	



**12) Pressure Gauge Information**

Single Gauge:

10,000 psi, QuartzDyne high pressure transducer, Model: QS20K-B

Model: PPS25

SN: 4108

Installed at: 8,981.0' WLM

Pressure accuracy: 0.030% FS (+/-1.21 psi)

Last calibration: April 02, 2014

Calibration certificate for the gauge is attached.

Gauge supplied by Pioneer Petrotech Services Inc. (sales@pioneerps.com)

**13) General Test Information**

Date of test: Injection commenced March 24, 2015, ceased March 25, 2015.

Bottom hole pressure monitored from March 23, 2015 to March 30, 2015.

Rate/Time information plotted from March 24, 2015 to March 30, 2015.

Time synchronization: see attached data files.

Location of shut-in valve: well was shut in at the wellhead

**14) Reservoir Parameters**

Water viscosity ( $\mu$ ):	0.2313 cp	(correlation)
Porosity ( $\phi$ ):	6%	(measured- density log porosity)
Total Compressibility ( $c_t$ ):	9.36e-06	(correlation)
Formation Volume Factor:	1.055 rb/stb	(correlation)

Formation reservoir pressure: From the attached semi-log Diagnostic Analysis Radial diagnostic plot,  $p^*$  is approximately 3,999 psia at perforation midpoint. This is 30 psi above the 3,969  $p^*$  estimated from the semi-log (radial) Diagnostic Analysis plot on the last pressure falloff test run in March, 2014.

Final injection pressure is approximately 4,565 psi, 91 psi above the 24-hour injection pressure on the March, 2014 pressure falloff test.



A summary of historical estimated Formation Reservoir Pressure ( $p^*$ ) values at 9,347' perforation mid-point using a 0.442 psi/ft hydrostatic gradient follows:

July, 1993	4,417 psia, unreliable (23 hour shut in, surface gauges, no radial flow)
November, 1997	3,590 psia
October, 2001	3,760 psia
February, 2003	3,830 psia
April, 2004	3,859 psia (radial plot, multi-layer synthesis)
April, 2005	3,647 psia (radial plot, multi-layer synthesis)
April, 2006	3,656 psia (radial plot, multi-layer synthesis)
April, 2007	3,816 psia (radial plot, radial flow portion of radial test analysis)
March, 2008	3,694 psia (radial plot, single layer)
March, 2009	3,912 psia (radial plot, single layer)
March, 2010	3,931 psia (radial plot, single layer)
March, 2011	3,854 psia (radial plot, single layer)
March, 2012	3,828 psia (radial plot, single layer)
March, 2013	3,809 psia (radial plot, single layer)
March, 2014	3,969 psia (radial plot, single layer)
March, 2015	3,999 psia (radial plot, single layer)

Date Reservoir Pressure was last stabilized: Stabilization likely occurred during a workover in March, 2003, 144 months prior to this test.

Justified Interval Thickness: Tracer survey run 5/6/13 & temperature logs run 5/6/13 indicate entire 142' perforated interval is taking fluid. Wireline 1/8/03 & during 3/03 workover shows all perforations open.

#### 15) Waste Plume

Cumulative injection volume into completed interval: 6,037,870 bbls as of March 25, 2015 at 07:00 hrs (post-test volume, includes the 961.30 bbls injected on the current test). These figures were determined by using injection volumes supplied by the Colorado Oil & Gas Conservation Commission through December, 1997, and injection volumes supplied by the operator from January, 1998, through March, 2015.

There were 114,045 bbls water injected into this well in the year since the last test.

Calculated radial distance to the waste front: It is not possible to empirically calculate a distance to the waste front from this type of test as there is no contrast between historic waste plume viscosity and formation fluid viscosity.

Average historical waste fluid viscosity: Based on data provided, no direct viscosity measurements have been taken. Waste plume viscosity is assumed to be the same as formation fluid viscosity. Essentially all of the waste fluid injected into the Suckla Farms #1 has been oilfield produced water, which does not have a significant contrast to the Lyons formation water.



**16) Injection Period**

Time: 06:59:52 AM 3/24/2015 to 06:59:30 AM 3/25/2015, 23.994 hours, 961.30 bbls

Type fluid: oilfield brine/produced water

Pump Type: Water plant injection pump

Rate Meter: Halliburton digital turbine meter. SWD tanks were strapped before & after to confirm volume.

Final injection pressure, surface:	unknown
Final injection pressure at 9,347' mid-perf:	4,565.3 psia
Final injection temperature at 8,981' gauge depth:	158.4° F

**17) Falloff Period**

Total shut-in time: 06:59:30 AM 3/25/15 to 11:59:52 AM 3/30/15, 125.006 hours

Final shut-in pressure at 9,347' mid-perf:	4,035.2 psia
Final shut-in temperature at 8,981' gauge depth:	243.3°F

**18) Pressure Gradient**

A static gradient was run at the conclusion of this test. No fluid level was noted as the fluid level appeared to be at surface.

**19-20) Calculated Test Data and Corresponding Graphs**

Please see attached graphs of the current test:

Data Chart	(Rate & Pressure vs Time)
Diagnostic Analysis	(Log-Log Typecurve)
Diagnostic Analysis	(Radial Semi-Log Analysis)
Two Layer Reservoir Model	(Radial and Typecurve)

The Rate vs. Time plot shows bottom hole injection pressure had essentially stabilized after the 24 hour injection period at 4,401 psi gauge pressure. No pressure anomalies due to gauge temperature de-stabilization are evident during the test. Data quality appears good. Pressure change during later test times is 1.6 psi per time step. Gauge resolution (+/-0.0003 psi) is adequate for the observed pressure change.

The Diagnostic Analysis (Typecurve) shows that a short radial flow period was reached approximately 102.0 hours into the falloff portion of the test. Analysis of this region gives a system permeability of 0.44 md, with a skin factor of -5.67.



Using the permeability value calculated from the falloff period, we can calculate a radius of investigation from the falloff test as follows for  $t = 125.006$  hrs, with other parameters as defined above:

$$r_{inv} = \sqrt{\frac{kt}{948\phi\mu c_i}} = \sqrt{\frac{0.44 \cdot 125.006}{948 \cdot 0.06 \cdot 0.2313 \cdot 9.36 \times 10^{-6}}} = 668.32'$$

Radius of investigation = 668.32'

Plots were generated using the Saphir software package available from Kappa Engineering, Paris, France. A .ks3 data file is included on the attached CD.

## 21) Comparison with Petition Demonstration

Condition #5 on Page 12 in Permit # CO10938-02115 stipulates an upper limit of 8,300,000 barrels of injected waste. This corresponds with a waste front of 1,320', assuming piston displacement. The current volume of 6,037,870 barrels injected corresponds to a waste front of 1,156', assuming an injection interval of 142'. While the effective injection interval may be less than 142', the additional fracture porosity postulated in this, and previous reports makes 1,156' a conservative estimate of the radial front of the waste plume. If fractures exist, then the reservoir must contain additional storage in the fracture system, in addition to the 6% matrix porosity. This will have the result of increasing the effective porosity, which decreases the distance to the waste front for any assumed injection volume or effective zone height.

The injection front has progressed 11' since the March 2014 test. There are 164 feet remaining for the front to advance before the 1320' permit limit is reached. This represents approximately 14 years and 11 months at current conditions.

Equation:

$$r_{inj} = \sqrt{\frac{5.615 \cdot V \cdot B_w}{\pi \cdot h \cdot \phi}} = \sqrt{\frac{5.615 \cdot 6,037,870 \cdot 1.055}{\pi \cdot 142 \cdot 0.06}} = 1,156'$$

where  $V = 6,037,870$  bbls,  $B_w = 1.055$  rb/stb,  $h = 142'$ ,  $\phi = 0.06$

It is IPT's opinion that the current test design is adequate to investigate this reservoir, given the constraints of daylight-only injection operations and available water storage. IPT recommends that subsequent tests follow this same design, which has now been used for eleven consecutive annual tests.



**22) Radioactive Tracer Survey**

A radioactive tracer was not run during this test. The last radioactive tracer survey run in the Suckla Farms #1 was done May 6<sup>th</sup>, 2013.

**23) Unusual Permit Approval Conditions**

IPT is not aware of any unusual permit approval conditions.

Report prepared for Wattenberg Disposal, LLC. by

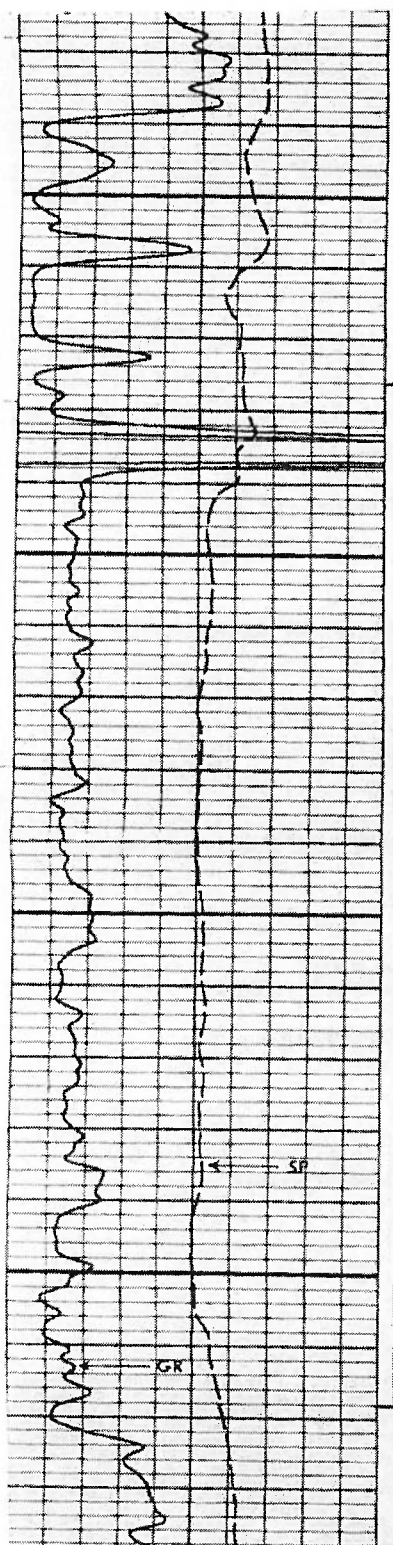
Integrated Petroleum Technologies, Inc.

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Eric Marshall, P.E.

April 03, 2015

Reference: EPA Region VI UIC Pressure Falloff Testing Guideline, Third Revision, August 8, 2002

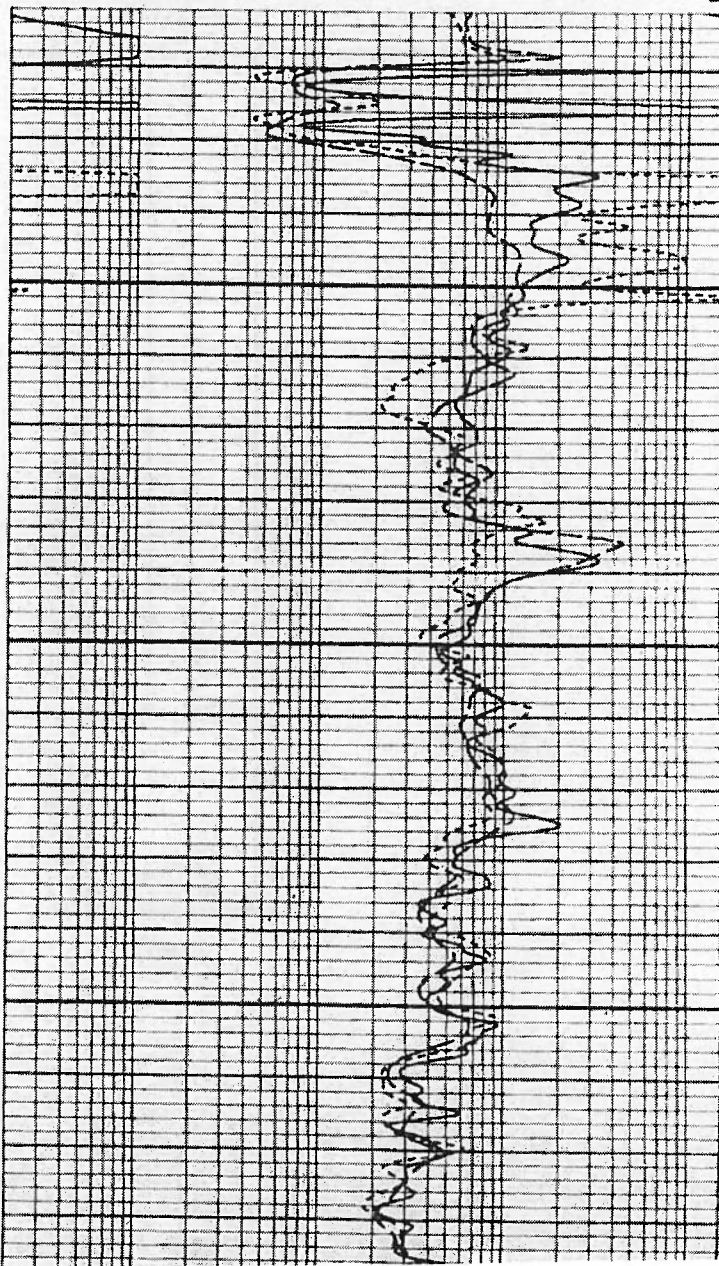


09300

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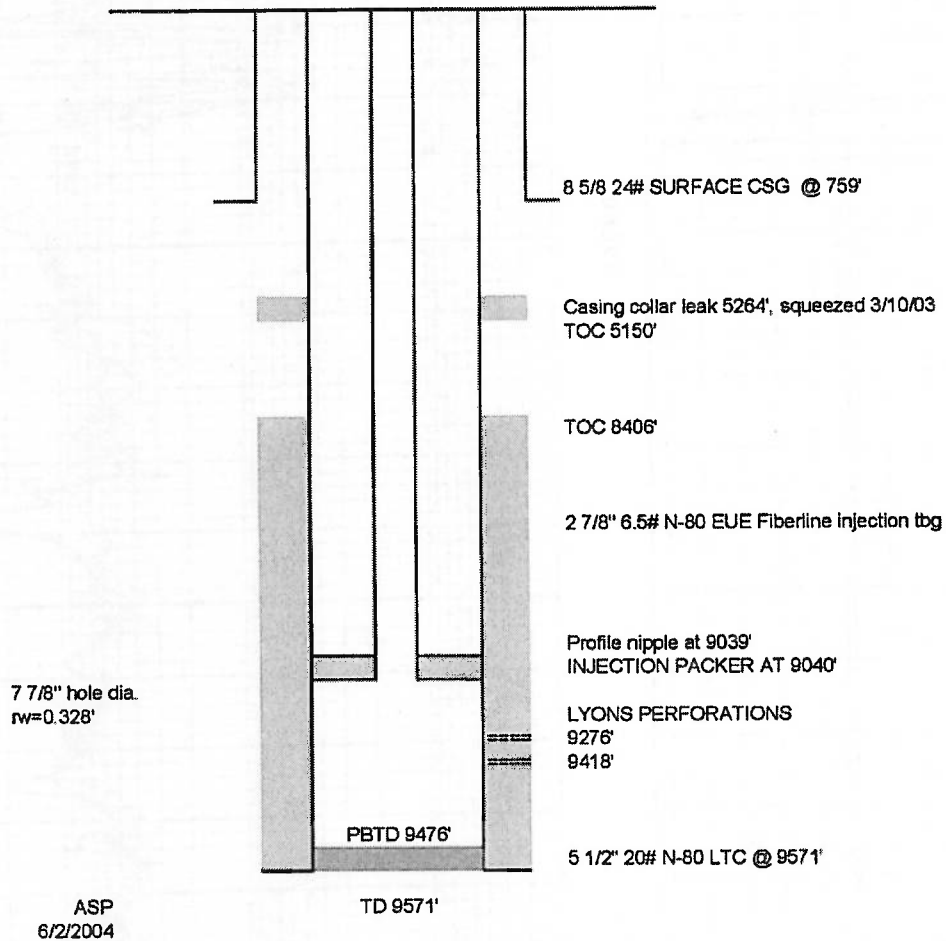
### Suckla Farms Injection Well #1 10-1N-67W





### WELLBORE SCHEMATIC

WATTENBERG DISPOSAL  
SUCKLA FARMS INJECTION WELL #1  
NW/4 SECTION 10-1N-67W  
WELD COUNTY, CO  
05-123-14291







**Pioneer Petrotech Services Inc.**

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[www.pioneerps.com](http://www.pioneerps.com)



ISO 9001:2008 Certified / FID 505687

## Calibration Certificate

Model:	PPS25	Pressure Range:	10,000 psi
Serial Number:	4108	Calibration Date:	Apr 02, 2014

### Specifications

Pressure Range:	Minimum: 13 psia	Maximum: 10,000 psia
Temperature Range:	Minimum: 0 °C	Maximum: 177 °C
Pressure Accuracy:	± 0.03 %F.S.	
Temperature Accuracy:	± 0.5 °C	
Housing Material:	INCONEL 718	
Housing OD	1.25"	

### Calibration Summary

Calibration Pressure Range:	Minimum: 13.12 psia	Maximum: 10,050 psia
Calibration Temperature Range:	Minimum: 0.90 °C	Maximum: 177 °C
Pressure Accuracy (Maximum Error):	+ 1.21 psi	
Temperature Accuracy (Maximum Error):	+ 0.25 °C	

### Working Standards

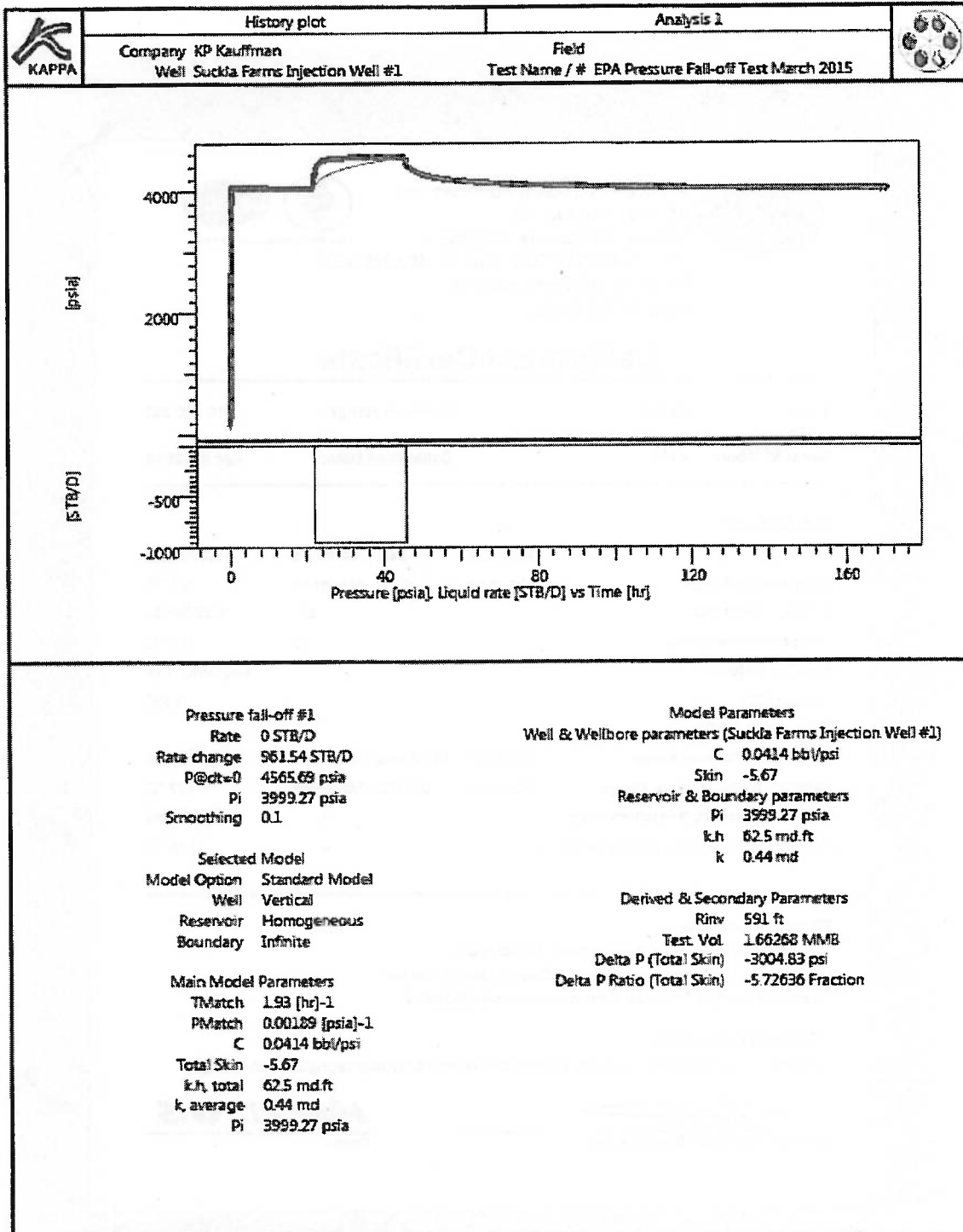
Sun Systems Environmental Chamber, Model: EC12  
QuartzDyne Transducer Interface and Display, Model: Series I  
QuartzDyne High Pressure Transducer, Model: QS20K-B

### Traceability Statement

All working standards are traceable to nationally or internationally recognized standards.

Pioneer Petrotech Services Inc.

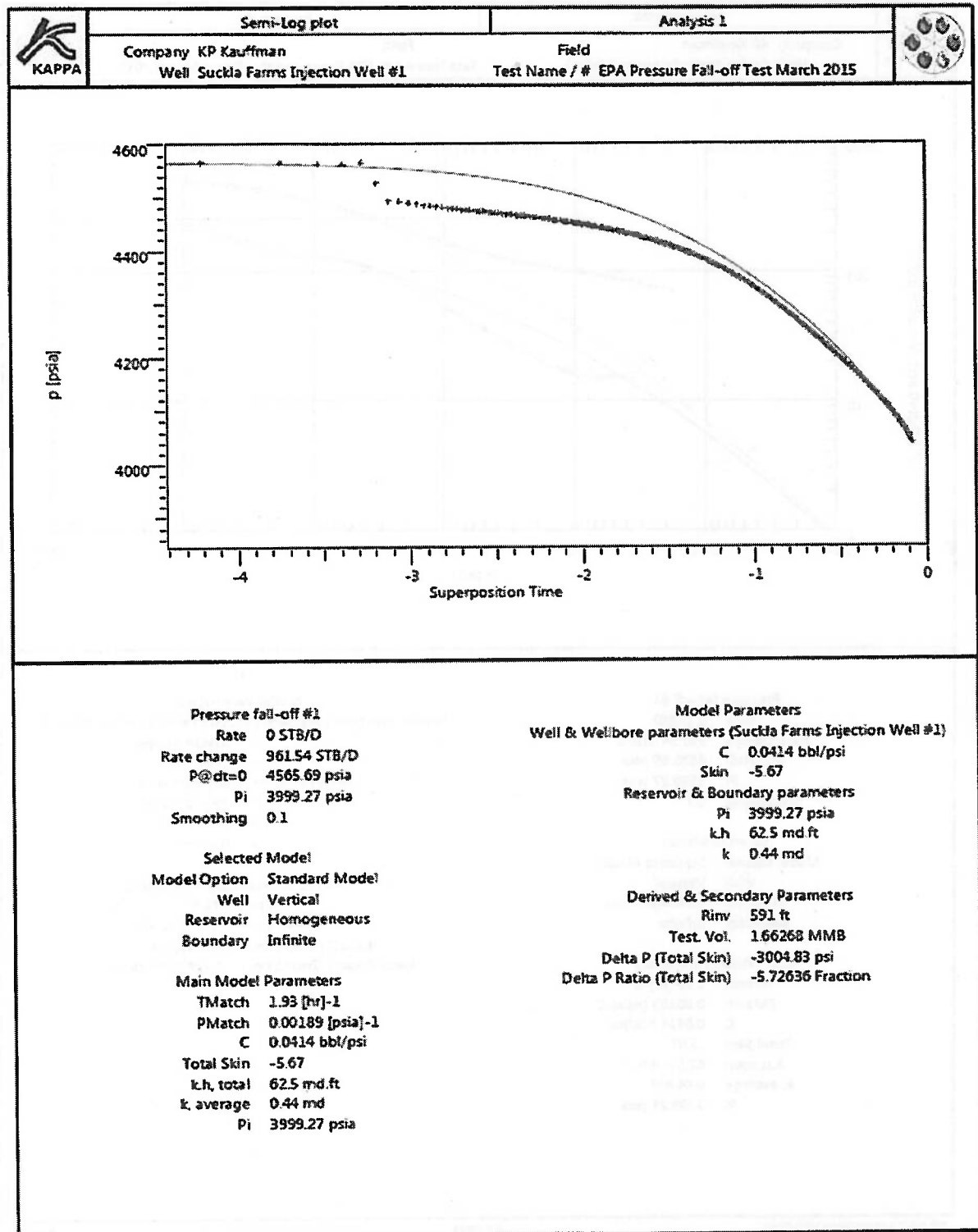
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Date



Early vs. Late Suckla Farms Injection Well #1, 2015-03-03

4/1/2015

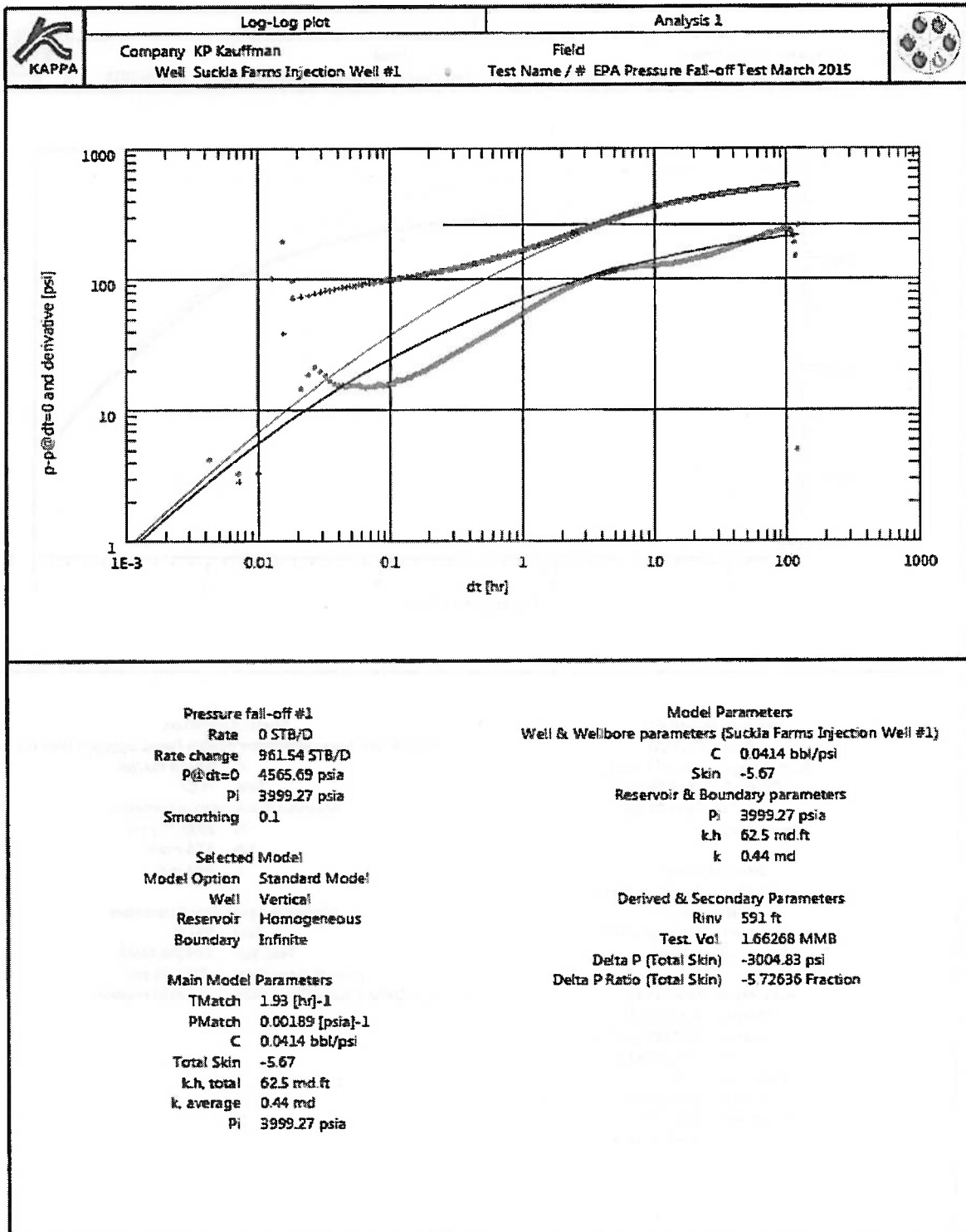
Page 1/1



Form: v4.00.07 Suckla Farms Injection Well #1 March 2015

4/1/2015

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